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# The influence of salt concentration on an enchytraeid population in pine litter[1])

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With one figure

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## 1. Introduction

In horticulture, plants are usually grown in an optimal substrate. In the Ghent area the substrate for most greenhouse plants and azalea is pine litter. Environmental influences are taken for granted, especially if mechanisation is involved but the following factors can be mentioned: water and temperature control, application of liquid fertilizers and, eventually, treatments with pesticides. Many studies have been conducted on the influence of pesticides on the fauna, but much less research has been devoted to the study of the effects of salt concentrations. We observed that as long as a considerable number of enchytraeids was present the growth of azaleas in pine litter substrates progressed satisfactority.

Because azaleas are salt sensitive ornamental plants, a study of the influence of the salt concentration on the enchytraeid fauna in pine litter, in view of plant-fertilizer interactions on enchytraeids, is of interest.

## 2. References

From the literature it appears that the application of organic fertilizers to mineral soils causes a pronounced increase in earthworm populations. Much less is known concerning the enchytraeids.

Franz (1953), Sauerlandt & Marzusch-Trappmann (1959, 1962), Sauerlandt et al. (1961) and Kipenvarlic (1964) noted increases in enchytraeid populations after application of manure, but the observed increases were much lower than these of earthworms.

Our observations on the pine litter substrate gave similar results (Heungens & van Daele 1970) with an increase that did not exceed 29 %.

From Marshall's review of the literature on the subject it can be concluded, that the effects of mineral fertilizers on earthworms differs greatly. Sulphates and phosphates may be detrimental to many earthworm species, but other fertilizers tend to favour earthworm population.

Many authors have noted an increase in earthworm populations as a result of increased production of agricultural crops following fertilizer applications but for the enchytraeids the conclusions are more explicit.

Marshall (1977) gave the following summary: "Although these worms may benefit from fertilizers, they appear to be very sensitive to some formulations. During the first year after the application of a complete fertilizer at the rate of 800 kg/ha, enchytraeid populations decreased by 70 % of the controls, then they recovered and from 3 to 5 years after fertilization enchytraeids were the only soil faunal group to show a clear increase (80 %) over controls (Huhta et al., 1964)".

With nitrogenous fertilizers Marshall (unpublished) noted a relatively high differences in effects depending on the enchytraeid species. Some species increased in numbers but the *Cognettia sphagnetorum*-population declined dramatically after application of urea at the rate of 160 kg/ha.

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## 3. Material and methods

Two different types of litter, an unused (fresh) pine litter and a pine litter used for one year, were used on an azalea nursery.

Both substrates from *Pinus sylvestris* litter were separated from wood fragments and cones and one litre samples put in plastic containers (10 × 10 × 15 cm). Since such substrates usually contain on increased enchytraeid population (normally 1000–3000 per litre), the substrates were not enriched with additional organisms. Some of the one litre samples (n = 40) were weighed wet and other samples after drying.

The results were as follows:

| | wet | | dry | | water-content |
|---|---|---|---|---|---|
| | $\bar{x}$ | s | $\bar{x}$ | s | $\bar{x}$ |
| fresh pine litter | 289 g | 18 g | 116 g | 14 g | 173 g |
| one year old | 383 g | 24 g | 148 g | 17 g | 235 g |

By weighing the plastic containers regularly, and adding a calculated amount of distilled water the weights and water contents were kept relatively stable.

To the substrates a salt series of 0 – 0.2 – 0.8 and 2 g per litre substrate was added, corresponding with a very low to a high conductivity for many ornamental plants.

The fertilizer Alkrisal (18-6-12) was chosen as salt, since it is generally accepted as having an appropriate NPK-ratio for azaleas.

The choice of the salt concentrations is justified by our previous publications (Heungens & Roos, 1975; Heungens et al., 1975). In the latter paper (Heungens et al., 1975) two methods of determining the conductivity (salt concentration) of a substrate were used. We compared two solutions after 24 hours:

(1) 4 g air-dried substrate + 100 ml water. (2) 100 ml normally wet substrate + 400 ml water.

The results proved that the conductivities are approximately the same for a pine litter substrate (not for peat). In this paper the second method was used.

Leaching of the salts in the plastic containers was prevented by closing them periodically and the evaporation was kept as low as possible. The experiments started mid-November. The temperature varied from 14 to 16 °C.

*p*H and conductivity (microSiemens/cm) were measured after three weeks and gave following results:

| | | mean and standard deviation of conductivity ($\mu$S/cm) | |
|---|---|---|---|
| pine litter | salt concentration | $\bar{x}$ | s (n = 6) |
| fresh | control | 247 | 32 |
| | very low | 274 | 26 |
| | medium | 475 | 30 |
| | high | 915 | 61 |
| one year old | control | 195 | 14 |
| | very low | 268 | 13 |
| | medium | 445 | 32 |
| | high | 845 | 62 |

For the whole of the test period, in the different treatments the *p*H varied from 4.1 to 4.7.

The Baermann-method was used for extracting the enchytraeids using samples that had a volume of 100 ml. The enchytraeids were sampled 1, 2 and 3 months after the beginning of the test. The dominant species was *Cognettia sphagnetorum*. Ten replicates were taken totalling 240 samples for this experiment.

## 4. Results

In Table 1 the results of the analysis of variance of the number of enchytraeids per 100 ml substrate are given (after log (x + 1) transformation).

From this it can be concluded that the salt concentration as well as the time from the start of the test had an obvious influence.

In Tables 2 and 3 the arithmetic and transformed means for the different substrates, salt concentration and periods are given.

Table 1. Results of analysis of variance

| Source of variation | Sum of squares of deviations | Degrees of freedom | Mean square | F-values |
|---|---|---|---|---|
| type of litter (substrate) | 0.0288 | 1 | 0.0288 | 0.45 |
| period (time) | 10.6537 | 2 | 5.3269 | 83.06 ($P < 0.01$) |
| salt concentration | 43.1654 | 3 | 14.3885 | 224.11 ($P < 0.01$) |
| substrate-time | 0.2765 | 2 | 0.1383 | 2.15 |
| substrate-salt conc. | 0.6526 | 3 | 0.2175 | 3.39 ($P < 0.05$) |
| time-salt conc. | 0.4867 | 6 | 0.0811 | 1.26 |
| substrate-time-salt conc. | 0.5346 | 6 | 0.0891 | 1.39 |
| residual error | 13.8758 | 216 | 0.0642 | |
| total | 69.6741 | 239 | 0.2915 | |

Table 2. The mean number of enchytraeids in 100 ml substrate from the different treatments and periods

| Substrate | Period | Salt concentration | | | |
|---|---|---|---|---|---|
| | | control | very low | medium | high |
| fresh pine litter | after 1 month | 83.6 | 66.7 | 19.1 | 9.1 |
| | after 2 months | 36.7 | 20.2 | 8.8 | 2.3 |
| | after 3 months | 39.4 | 39.7 | 12.0 | 2.0 |
| pine litter | after 1 month | 108.8 | 44.0 | 32.4 | 8.9 |
| used during | after 2 months | 38.6 | 20.5 | 10.5 | 4.0 |
| one year | after 3 months | 40.3 | 18.7 | 10.7 | 2.4 |

Table 3. Mean of the number of enchytraeids in 100 ml substrate from different treatments and periods (transformed $\log(x + 1)$)

| Substrate | Period | Salt concentration | | | |
|---|---|---|---|---|---|
| | | control | very low | medium | high |
| fresh pine litter | after 1 months | 1.887 | 1.800 | 1.240 | 0.919 |
| | after 2 months | 1.505 | 1.230 | 0.891 | 0.316 |
| | after 3 months | 1.512 | 1.496 | 0.923 | 0.234 |
| pine litter | after 1 month | 1.976 | 1.588 | 1.457 | 0.903 |
| used during | after 2 months | 1.540 | 1.276 | 0.987 | 0.564 |
| one year | after 3 months | 1.530 | 1.197 | 0.922 | 2.076 |
| general transformed mean | | 1.658 | 1.431 | 1.070 | 0.535 |
| l.s.d. (0.01) = 0.120 | | | | | |

Logarithmic means according to the period: after 1 month 1.471; after 2 months 1.039; after 3 months 1.011; l.s.d. (0.01) = 0.104.

From Tables 2 and 3 the very pronounced influence of an enhanced salt concentration on the enchytraeid fauna can be seen. Clearly, even the lowest application of fertilizer (0.2 g/l) resulted in a decrease of the population density. This was also illustrated by the regression lines for the three periods (Fig. 1).

For the different periods, the correlation gives relatively high negative values of −0.84 to −0.86, which are all statistically significant.

As shown in Table 4 a conspicuously lower mortality results from the application of pesticides compared to mineral fertilizers.

Table 4. Mean number of enchytraeids in 100 ml pine litter in azalea culture after pesticide treatment

| Product | Dose per litre substrate | Mean number |
|---|---|---|
| control (1) | — | 212 |
| aldrin (1) | 10 mg/l | 249 |
| carbaryl (1) | 10 mg/l | 190 |
| DBCP (1) | 37.5 mg/l | 255 |
| control (2) | — | 92 |
| dimethoate (2) | 2.5 mg/l | 72 |
| propoxur (2) | 5 mg/l | 72 |
| dicofol (2) | 5 mg/l | 65 |
| thionazin (2) | 5 mg/l | 37 |
| aldicarb (2) | 3 mg/l | 92 |

(1) Source: Heungens (1969) — mean number after 2 months;
(2) Source: Heungens (1970) — mean number after $3^1/_2$ months.

It should be observed that in the pesticide experiments leaching was possible, which was not so in the salinity experiments. A lasting and high salinity is possible in ornamental culture after repeated fertilization, and this can exterminate the enchytraeid populations.

In biological soil analysis (Heungens & van Daele 1977) a very low enchytraeid population constituted an indicator of an overdose of mineral fertilizer.

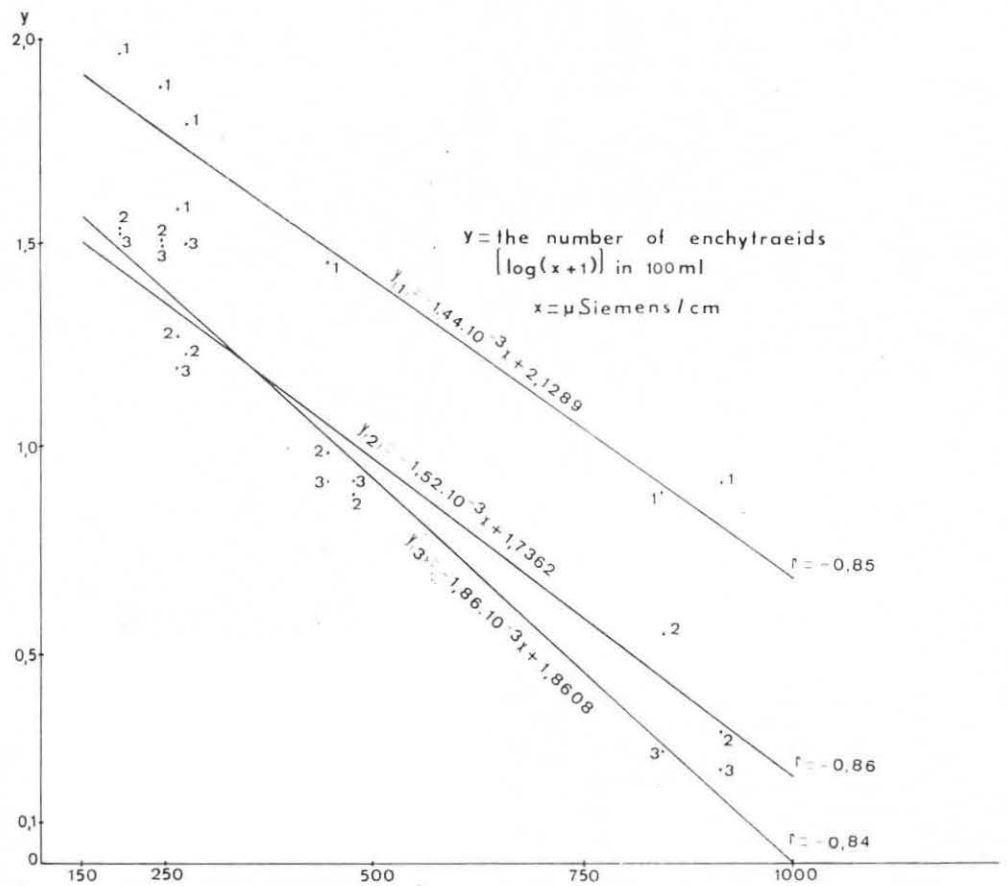


Fig. 1. The regression lines for the 3 periods (1, 2 and 3 month after treatment).

## 5. Summary · Zusammenfassung · Résumé

An analysis of variance of the results of laboratory experiments with two pine litter substrates, three times of sampling and four doses of fertilizers demonstrated clearly that the application of a compound chemical fertilizer caused a drastic decrease in the enchytraeid population. A constant dose of 2 g of the mineral fertilizer Alkrisal (18-6-12) per litre of pine litter caused a 90 % mortality of the enchytraeid fauna after one month and a 95 % mortality after three months.

The recommended use of pesticides would not result in a comparable degree of mortality.

### Der Einfluß unterschiedlicher Salzconcentrationen auf die Enchytraeidenpopulationen in Nadelstreu

Die Varianzanalyse der Ergebnisse von Laborversuchen mit zwei Arten von Kiefernadelstreu, drei Momenten von Stichprobenentnahmen und vier Düngemittelapplizierungen zeigt eindeutig, daß die Anwendung eines zusammengesetzten chemischen Düngemittels zu einer drastischen Abnahme der Enchytraeidenpopulationen führt. Eine konstante Dosis von 2 g Alkrisal (18-6-12) je Liter Kiefernadelstreu ergibt nach einem Monat eine 90%ige und nach drei Monaten eine 95%ige Abtötung der Enchytraeiden.

In der Praxis weist die Anwendung von Pestiziden keine vergleichbare Mortalität auf.

### L'influence de la salinité sur la population des enchytréides dans la litière de pin

L'analyse de la variance des résultats d'un essai en laboratoire sur 2 litières de pin, 3 périodes de prélèvements et 4 doses d'un engrais minéral démontrent clairement que l'application d'un engrais minéral diminue fortement la population des enchytréides.

Une dose constante de 2 g d'Alkrisal (18-6-12) par litre de litière occasionne une mortalité de 90 % après un mois et de 95 % après 3 mois.

Dans la pratique l'emploi de pesticides ne donne pas de résultats de mortalité comparable.

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